



OLLSCOIL NA GAILLIMHÉ  
UNIVERSITY OF GALWAY



An tIonad Aon Sláinte Amháin  
Centre for One Health

# Verotoxigenic *E. coli* (VTEC) in private wells

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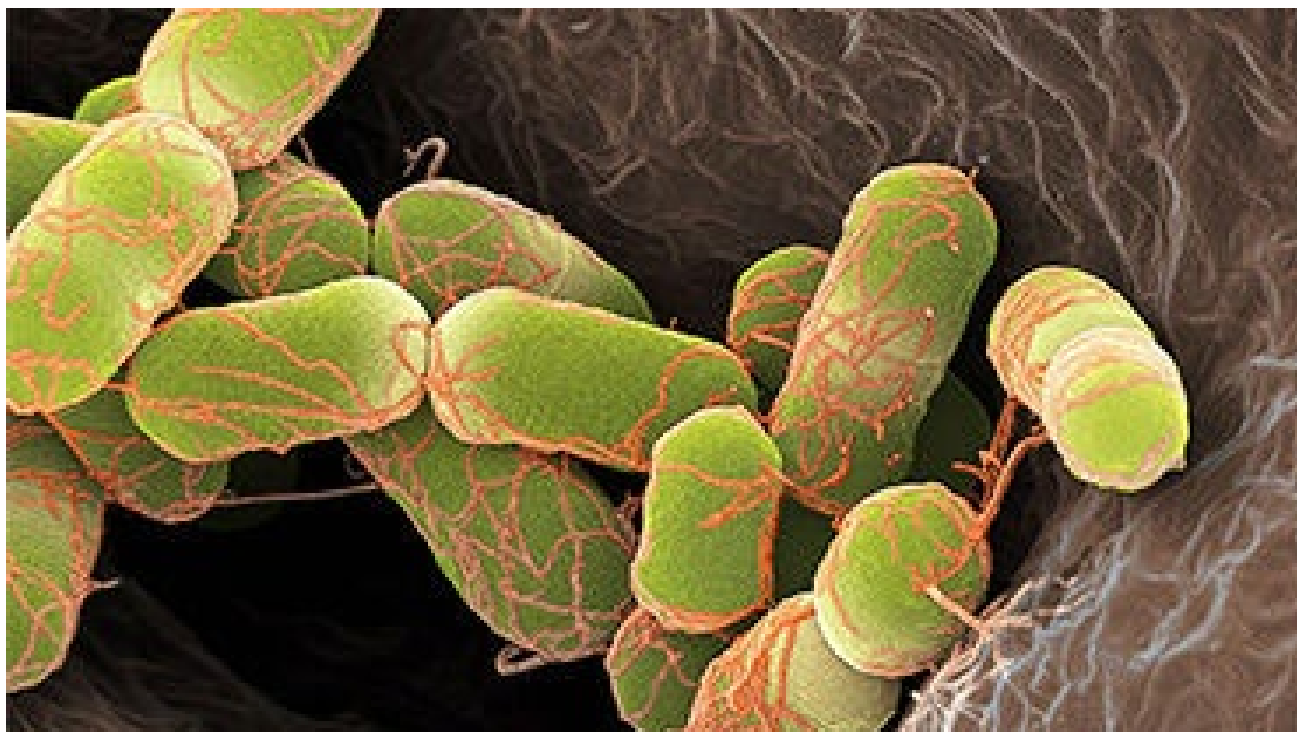
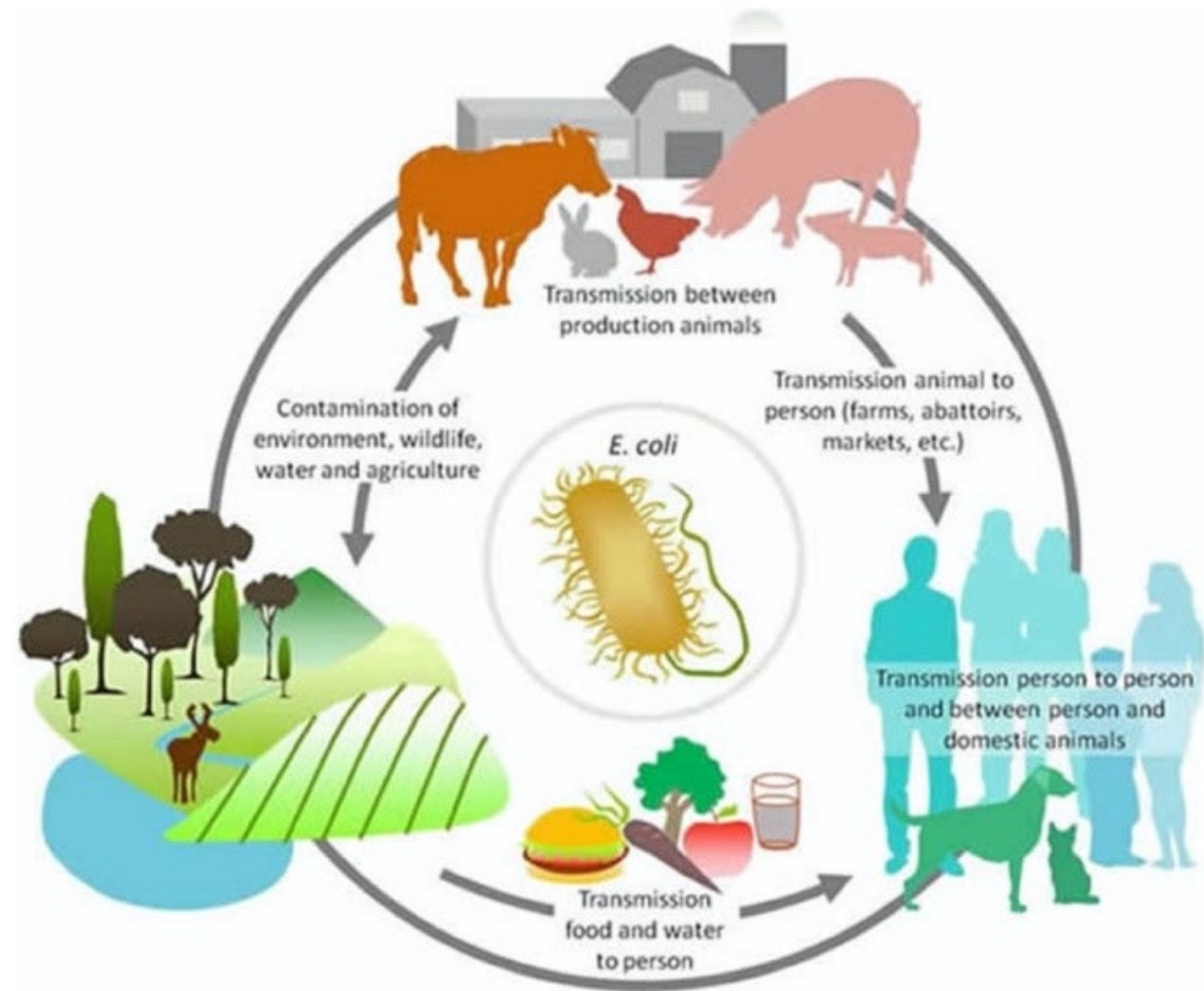
EPA Water Conference 2023  
June 15th  
Galway Bay Hotel, Salthill, Galway



University  
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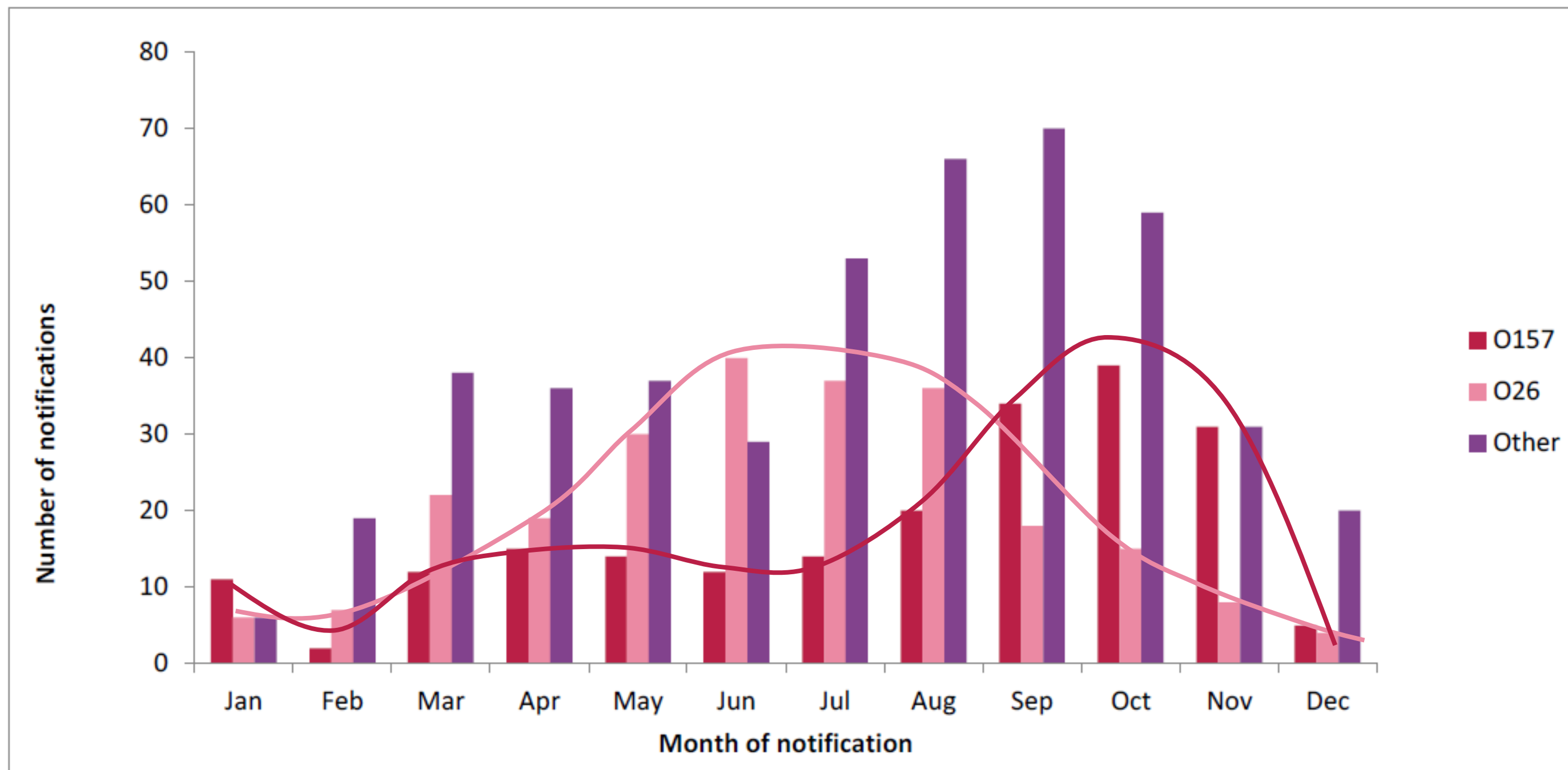
# What is VTEC?

- Pathogenic strain of *Escherichia coli*
  - Associated with ruminants
  - Produce enterotoxins ( shiga-toxins a.k.a. verocytotoxins)
  - Food and waterborne transmission
- Cause gastrointestinal infections:
  - Very low infectious dose: 10 - 100 cells
  - Bloody diarrhoea, abdominal cramps, vomiting
  - 33% cases require hospitalisation
- Haemolytic Uremic Syndrome (HUS) in up to 10% of cases
  - Mostly occurs in children, potentially fatal



# Seasonality of VTEC infection

**Figure 2.** Seasonal distribution of VTEC notifications by serogroup, Ireland, 2017

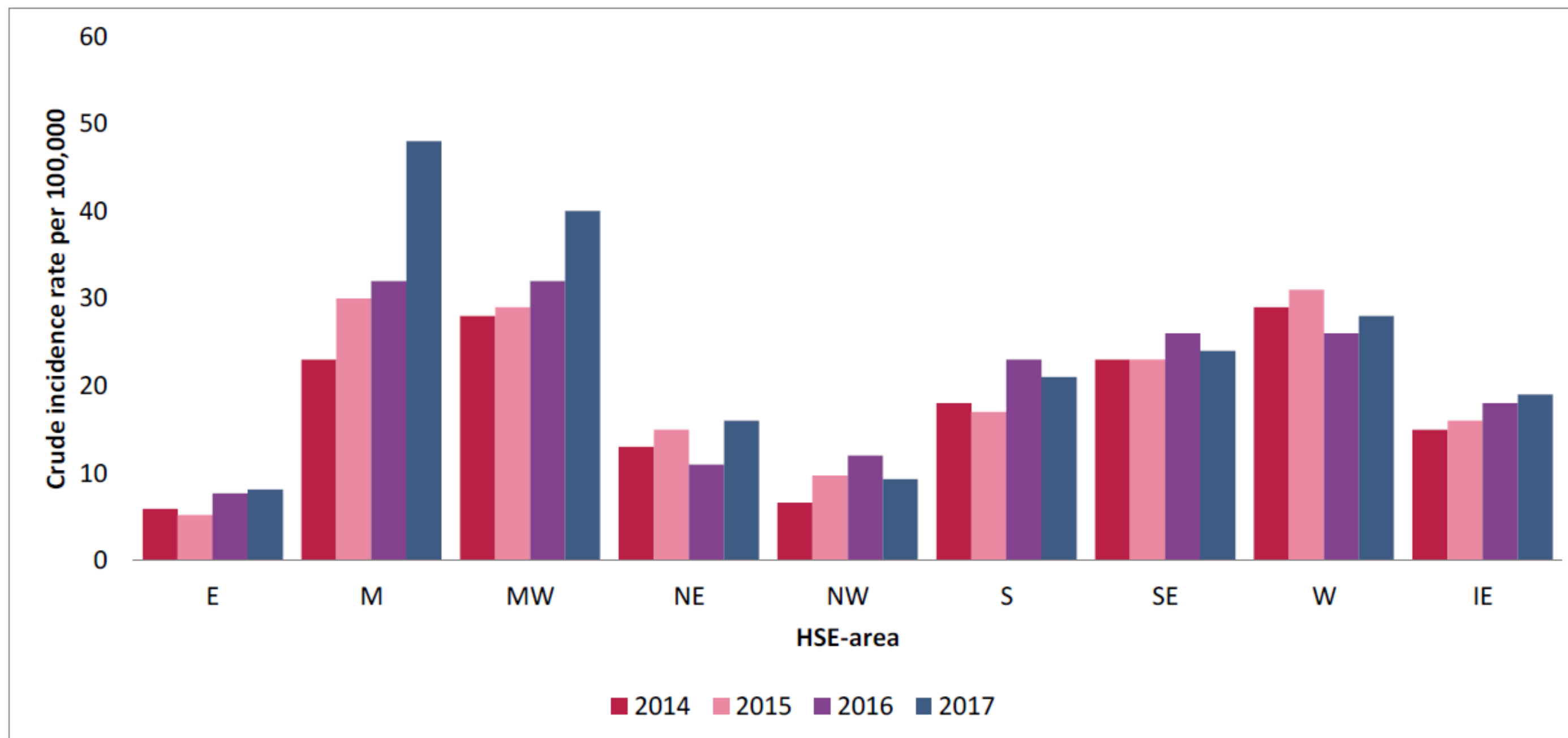


For simplicity mixed infections were recorded as O157 if at least one strain was O157, as O26 if at least one strain was O26 but not O157, and as Other if only non-O157 or non-O26 strains were detected.



# National distribution of VTEC infection

**Figure 3.** Crude incidence rate VTEC by HSE area, Ireland, 2014-2017

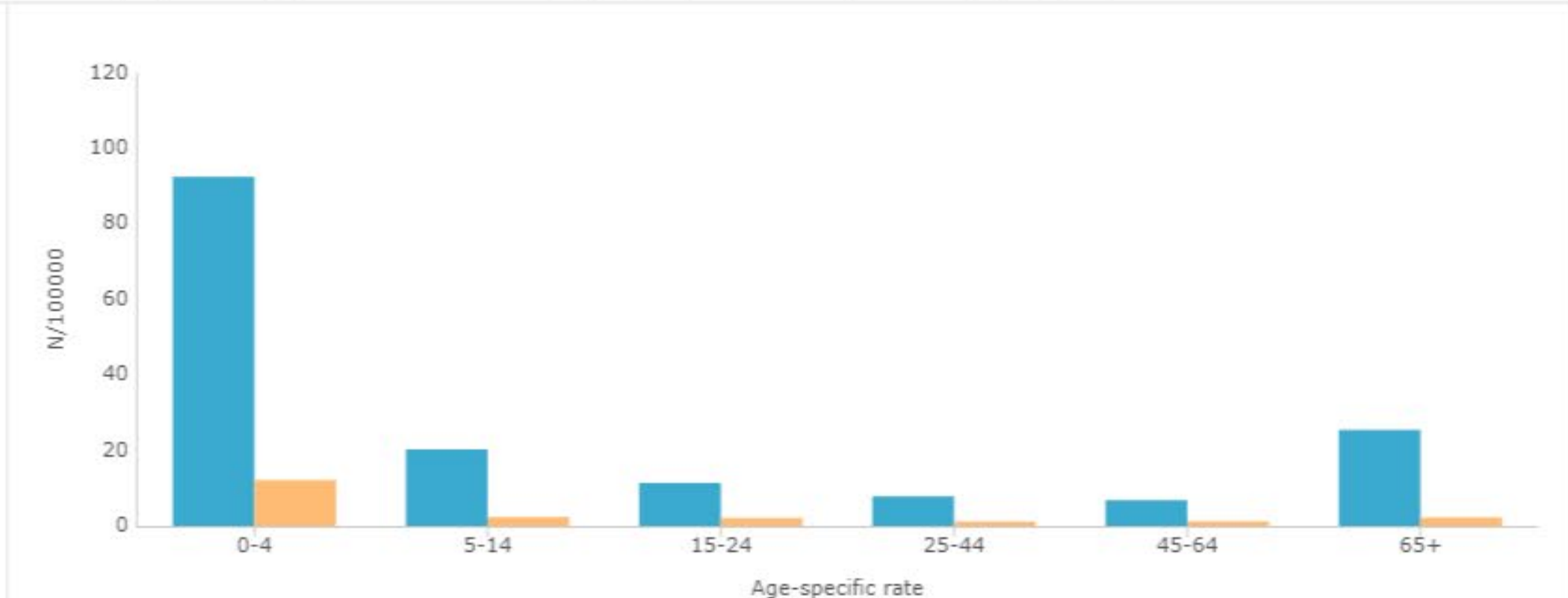
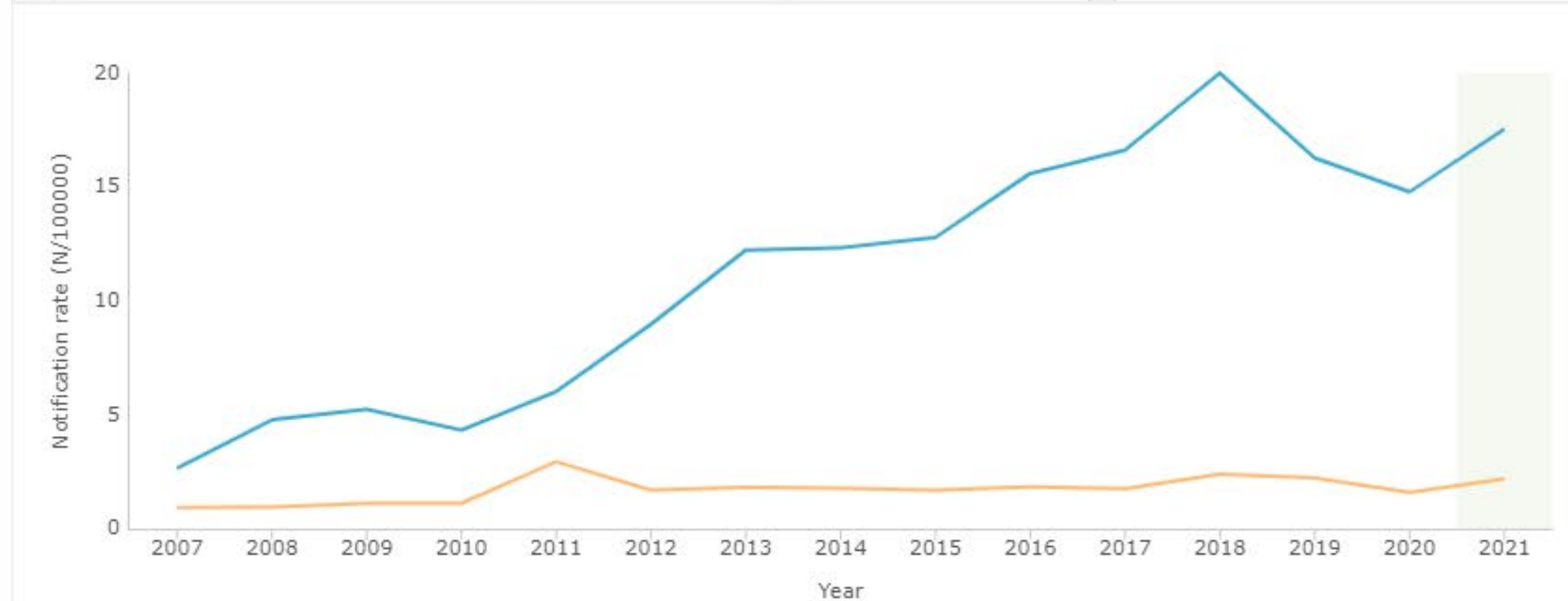
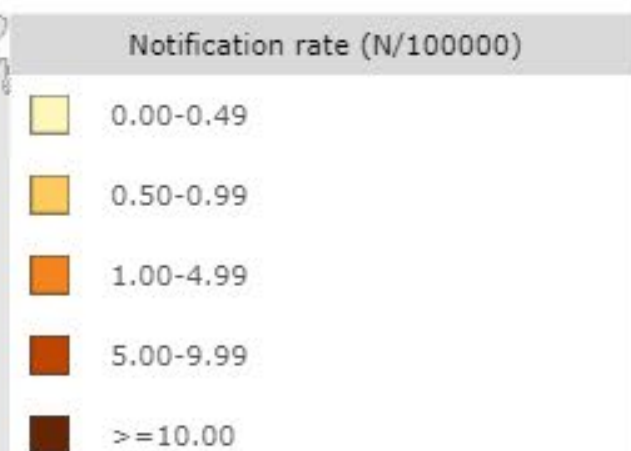
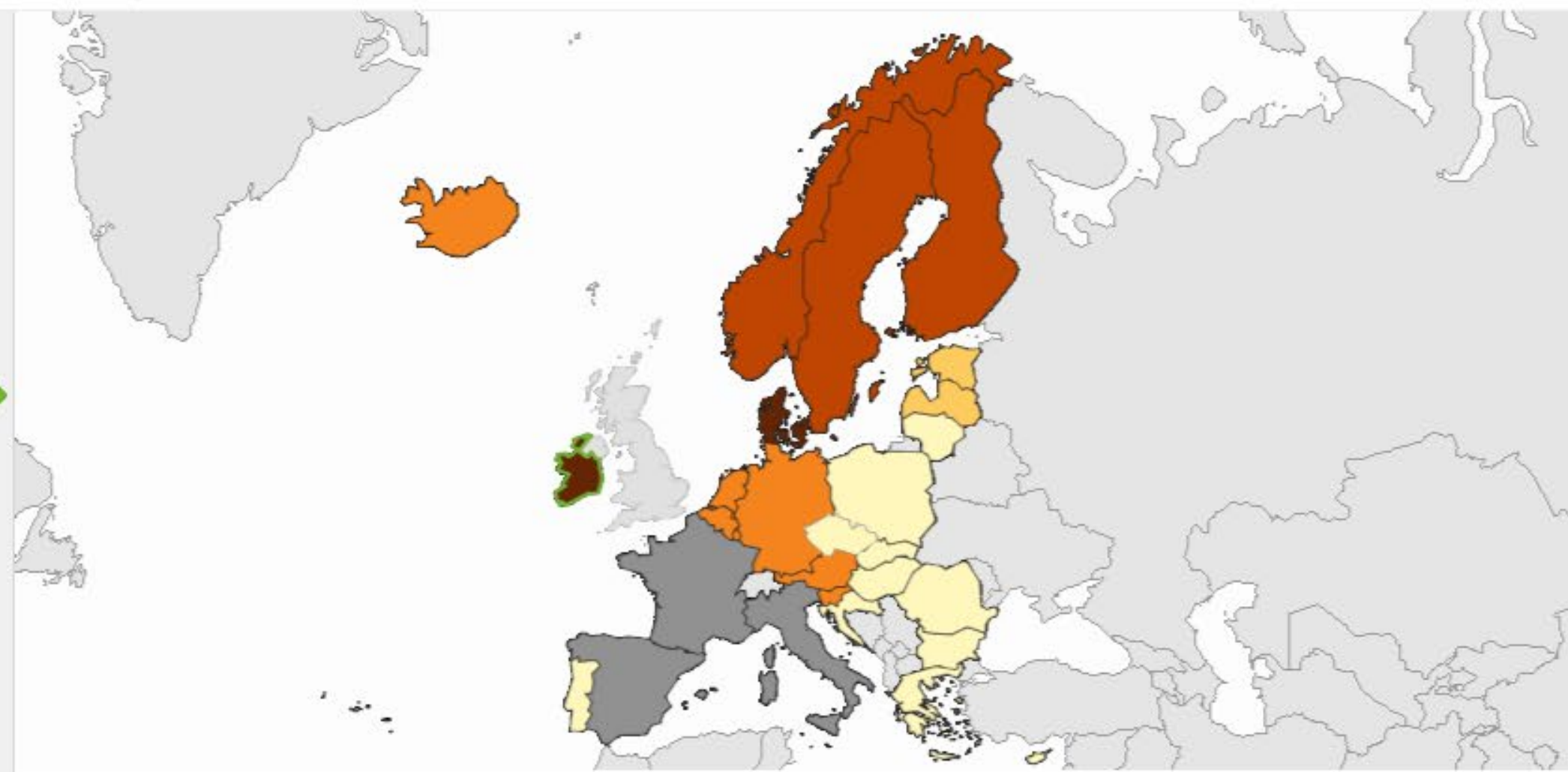


Note: For simplicity mixed infections were recorded as O157 if at least one strain was O157, as O26 if at least one strain was O26 but not O157, and as Other if only non-O157 or non-O26 strains were detected.



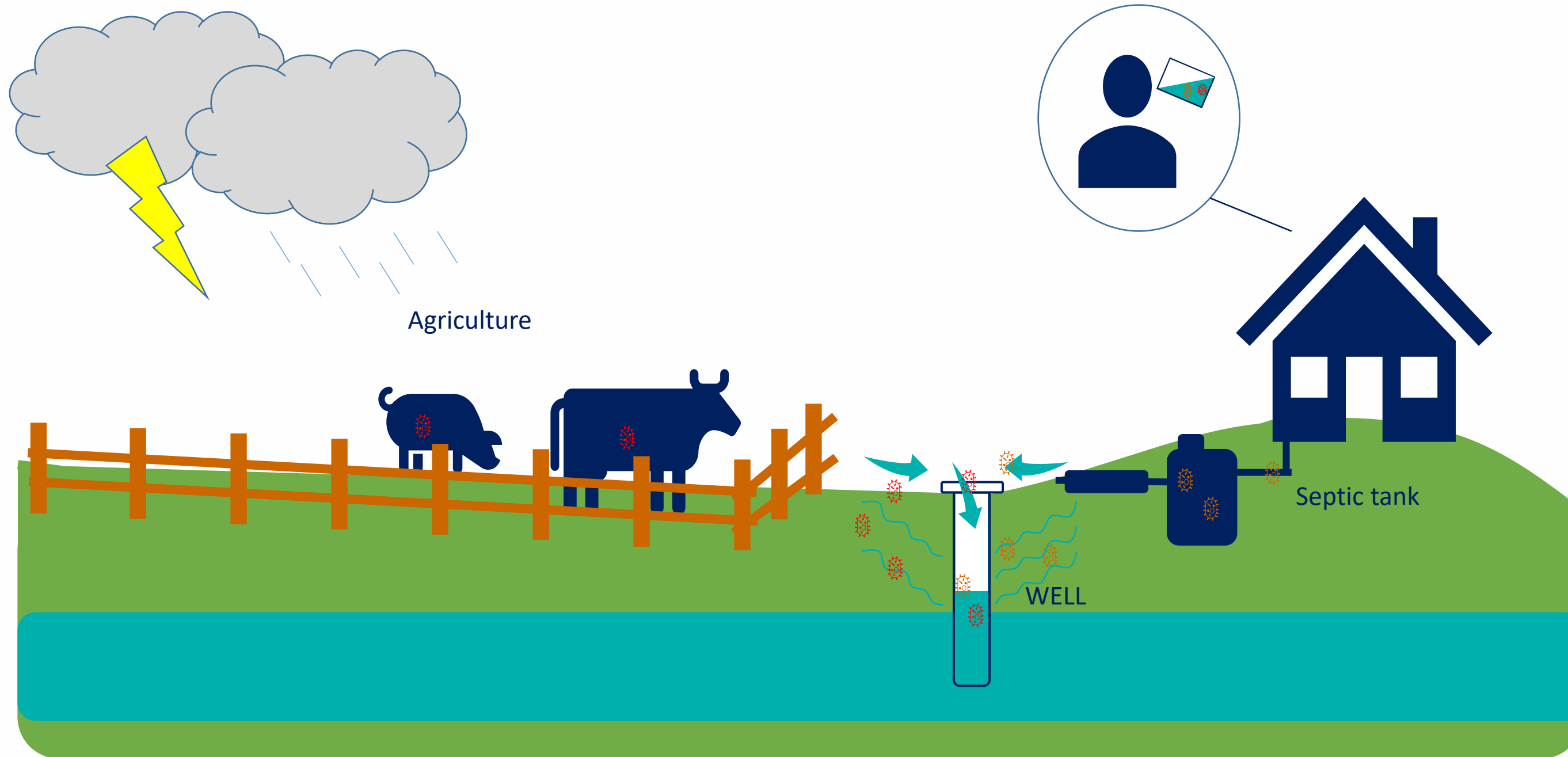
STEC/VTEC infection | Confirmed cases | Notification rate | 2021

Region	Notification rate (N/100000)
EU/EEA	2.18
EU	2.06
Ireland	17.54
Denmark	15.87
Liechtenstein	15.36
Malta	13.18
Norway	8.11
Sweden	6.29
Finland	5.20
Austria	4.29
Netherlands	2.77
Slovenia	2.28
Germany	1.97
Iceland	1.90
Luxembourg	1.58



Ireland EU/EEA

# Private wells in Ireland

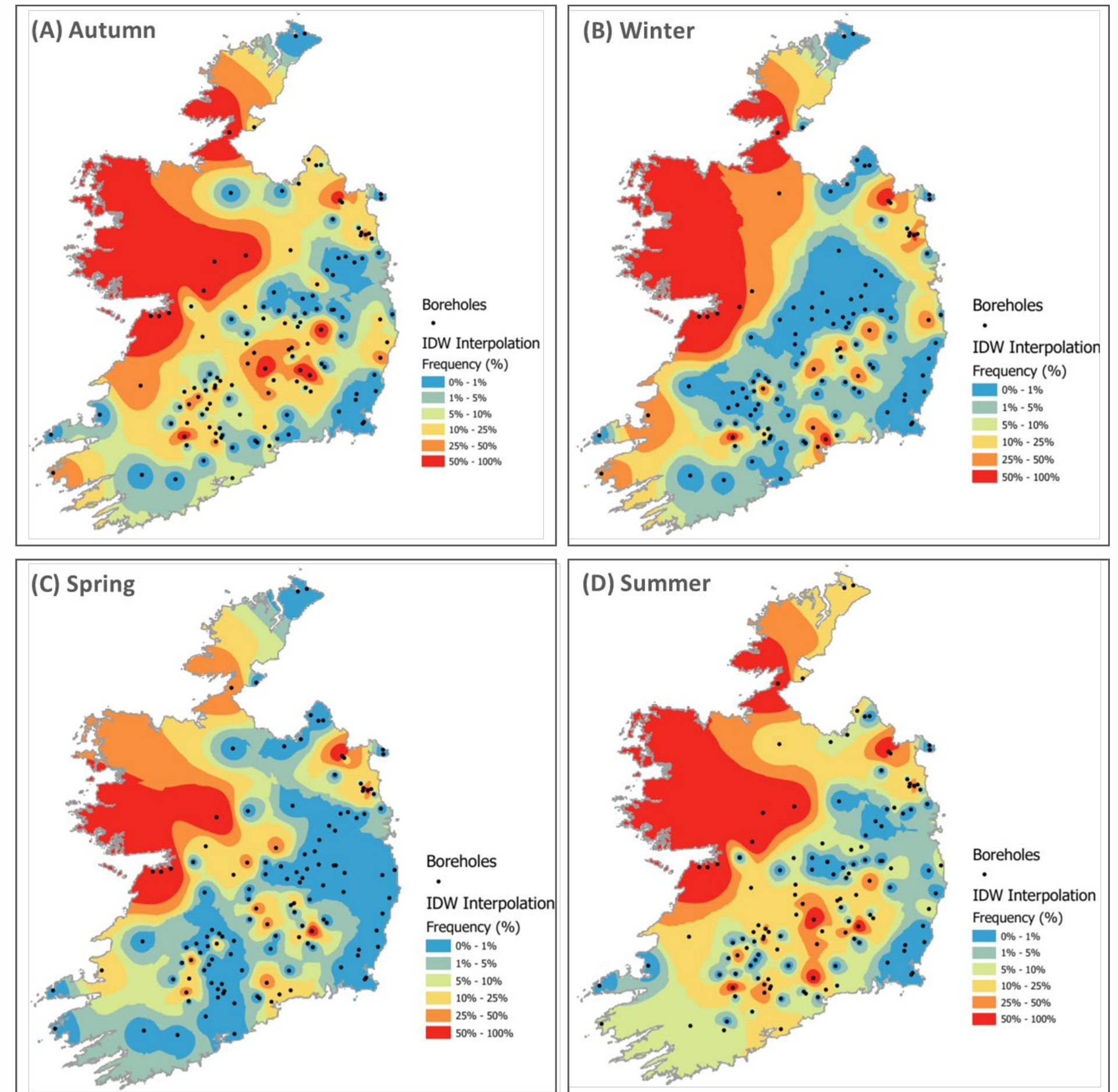


- Approx. **750,000 people** rely on groundwater for their drinking water
- Groundwater extraction is **unregulated** at the household level
- Groundwater supplies can be highly **vulnerable to contamination** with pathogenic microorganisms (source-pathway-receptor)
- Private well usage is the **top risk factor** for VTEC infection. 4 in 10 people infected are exposed.



# *E. coli* wells, a 10-year national perspective

- Andrade *et al* used EPA data collected from 132 water supply wells (private and public) between 2010 and 2019.
- In total, there were 3,811 samples.
- **68.2%** (90/132) of **water supplies** were contaminated with *E. coli* at least once
- **13.5%** (n = 515/3,811) of **water samples** tested positive for *E. coli*
- [Science of The Total Environment 840 \(2022\) 156311](#)



# *E. coli* and VTEC detection in wells



52 private wells in western Ireland assessed for contamination during autumn 2019 and 2021

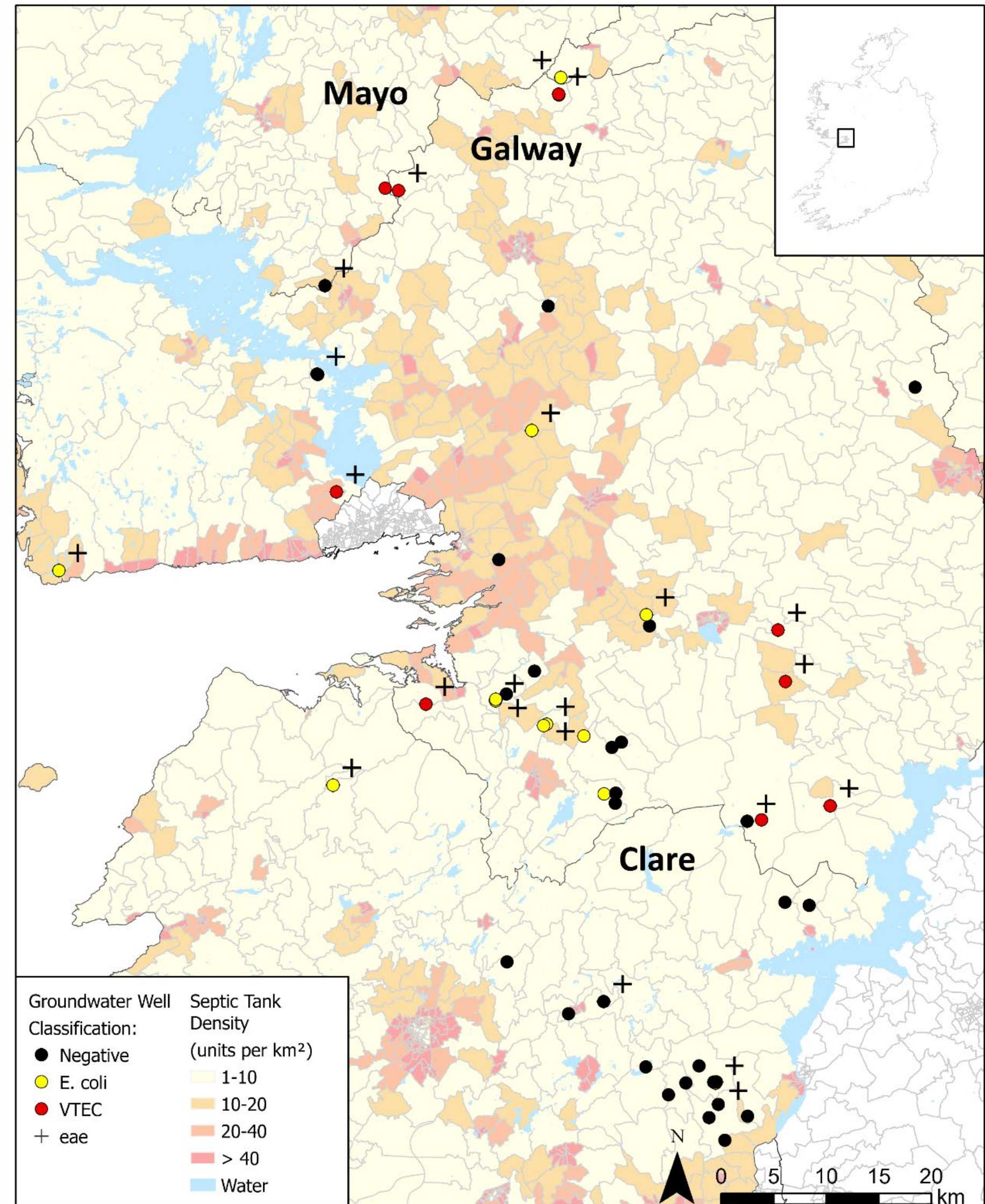
**38%** positive for *E. coli* (median 9 MPN/100 mL)

Verocytotoxin genes were detected in **19.2%** of wells and in **40%** of wells positive for *E. coli*

**Multiple** clinically relevant VTEC serogroups detected in wells with **>20 MPN/100 mL *E. coli***

15% of wells overall and 33% of *E. coli* contaminated wells were positive for both a verocytotoxin gene and the *eae* gene (*associated with more severe infection*)

[Science of The Total Environment 866 \(2023\)161302](#)





# Key Risk Factors



**(Hydro)geology:** odds of *E. coli* presence were 4, 5 and 21 times higher in areas of Moderate, Extreme and Rock/Karst than in areas of Low groundwater vulnerability, respectively.

**Septic tanks:** detection of generic *E. coli* was also associated with the presence of an adjacent (<100m) septic tank up-gradient of the wellhead ( $\chi^2 = 11.124$ ,  $p = 0.001$ ).

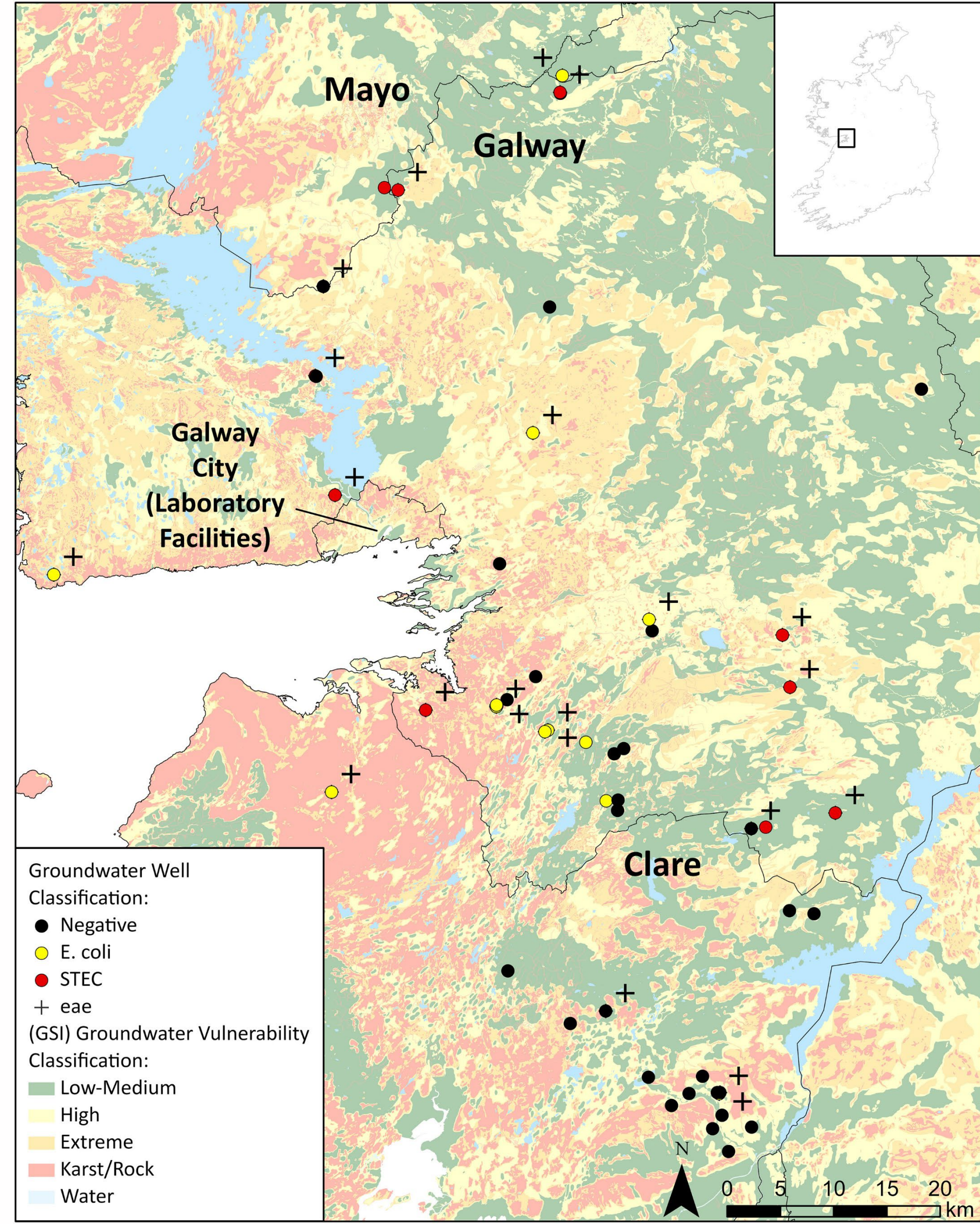
↑ **septic tank** density associated with (VTEC + *eae*) ( $p = 0.023$ )

**Rainfall:**

**VTEC** well contamination associated with mean antecedent **rainfall** ( $p = 0.030$ )      ↑ 30 day

**Well design:**

**VTEC** well contamination associated with **well depth** ( $p = 0.024$ )      ↓

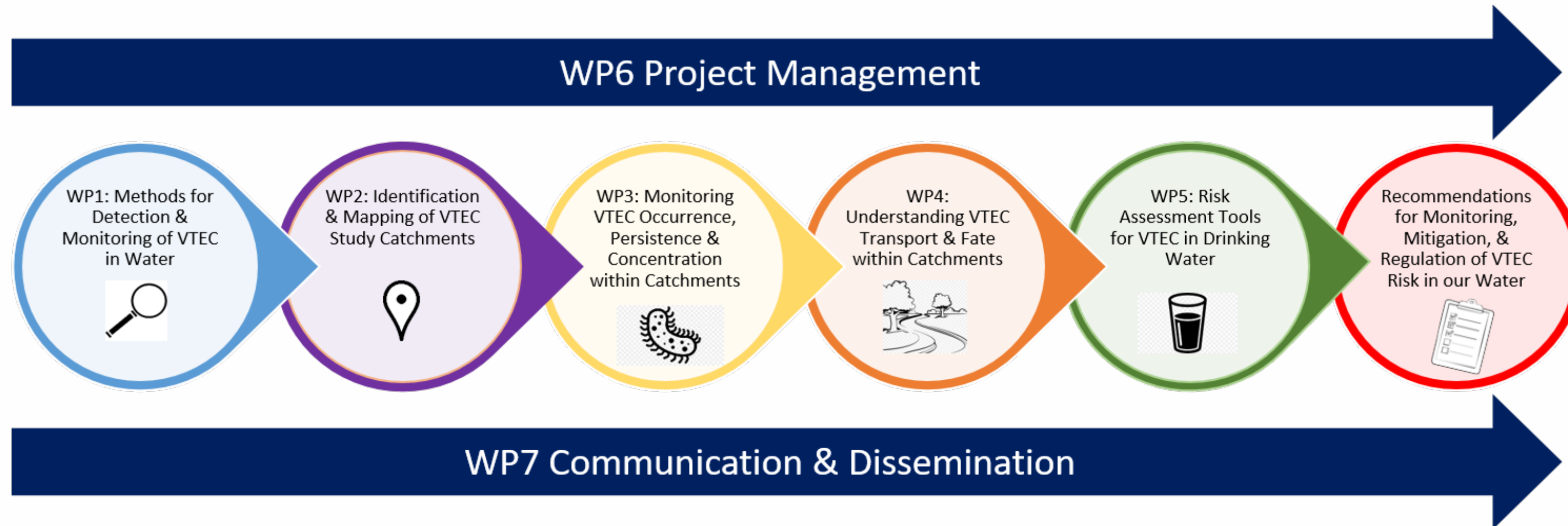




# Public health implications in numbers

- ~120,000 private wells in Ireland
- 38 - 68% of these could be contaminated with *E. coli* at any given time = 45,600 to 81,600 wells
- Of which 40% are potentially positive for VTEC = 18,240 to 32,640 wells
- CIR in Ireland (2021) for VTEC was 17.5/100,000
- For well users in Ireland the CIR for VTEC is much higher.





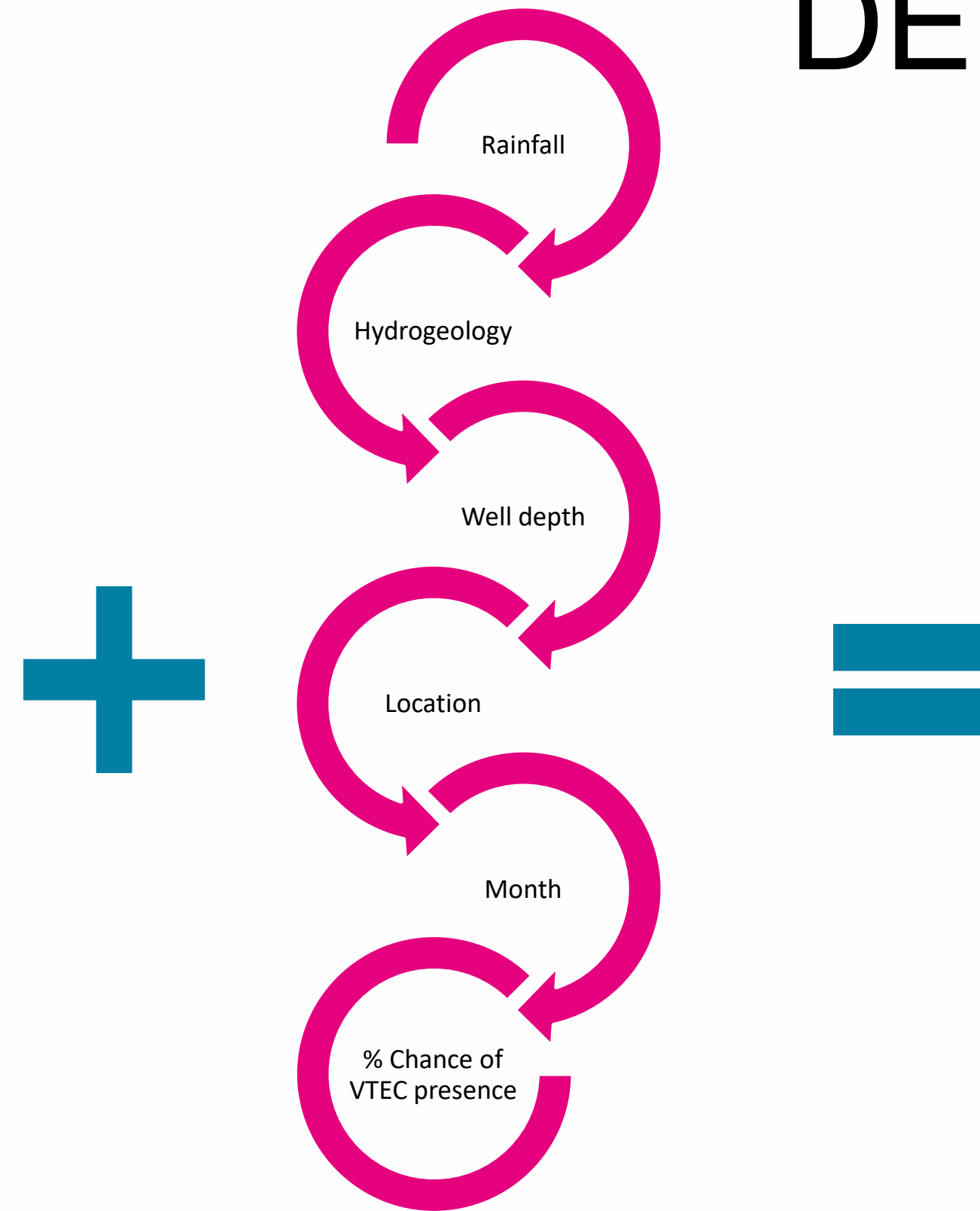
### Aims:

Draw evidence -based recommendations for policy pertaining to **detection, monitoring and regulation of VTEC** in our aquatic ecosystems and our drinking water supplies.

Inform novel **risk mitigation and management measures (new DWD)** that can be applied at catchment level to break the pathway from source to receptor.



Rapid on-site detection



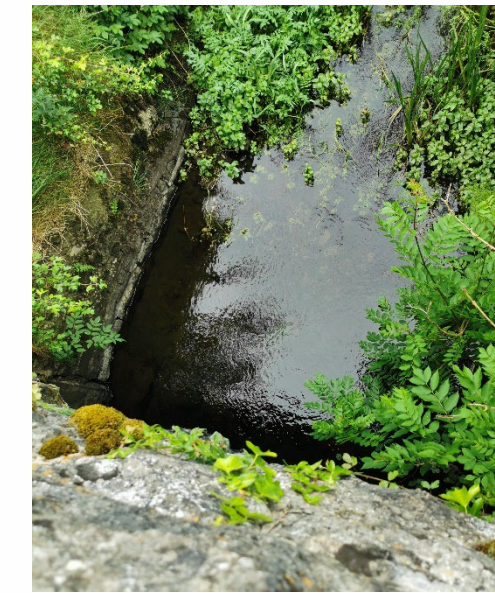
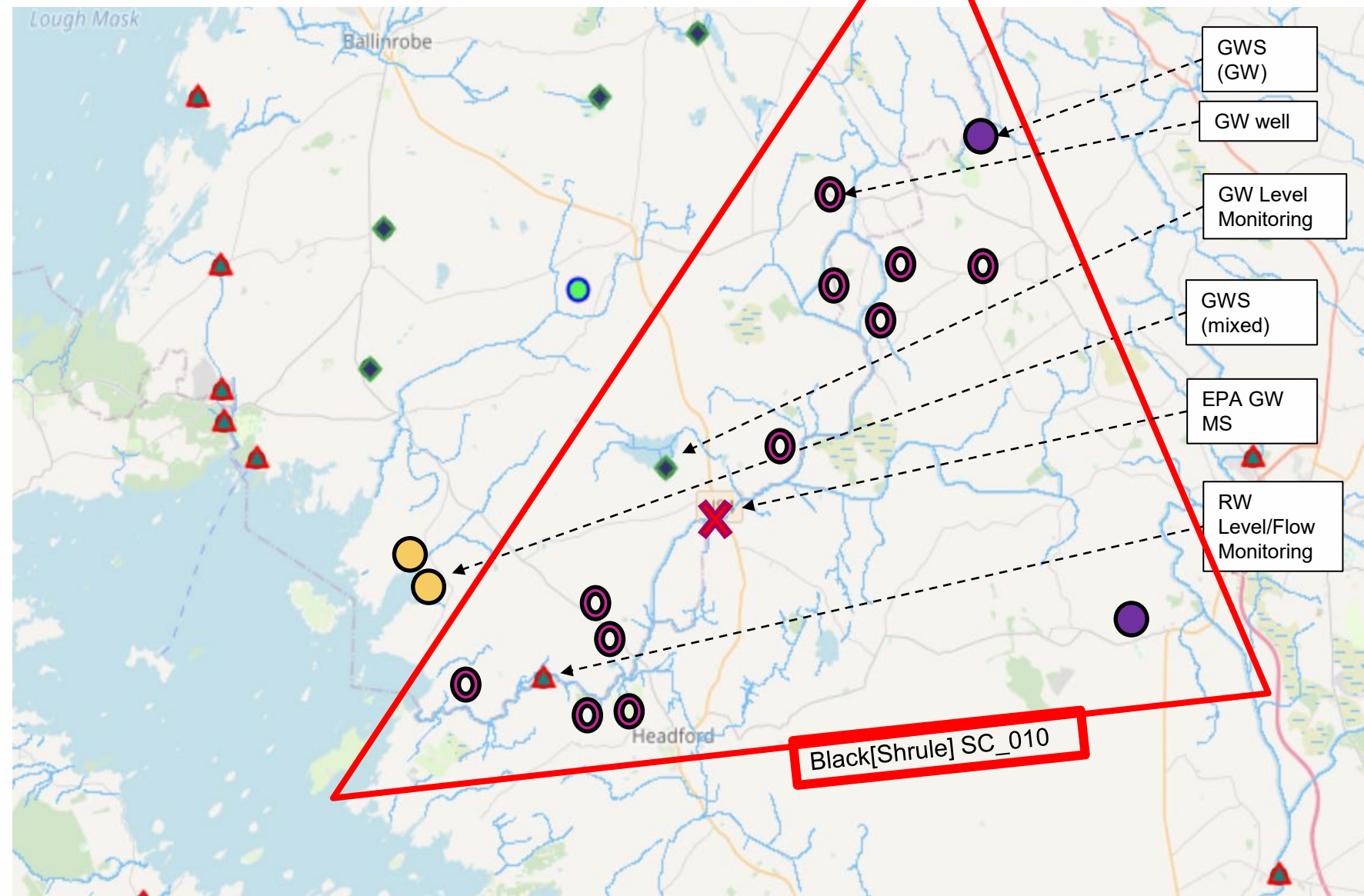
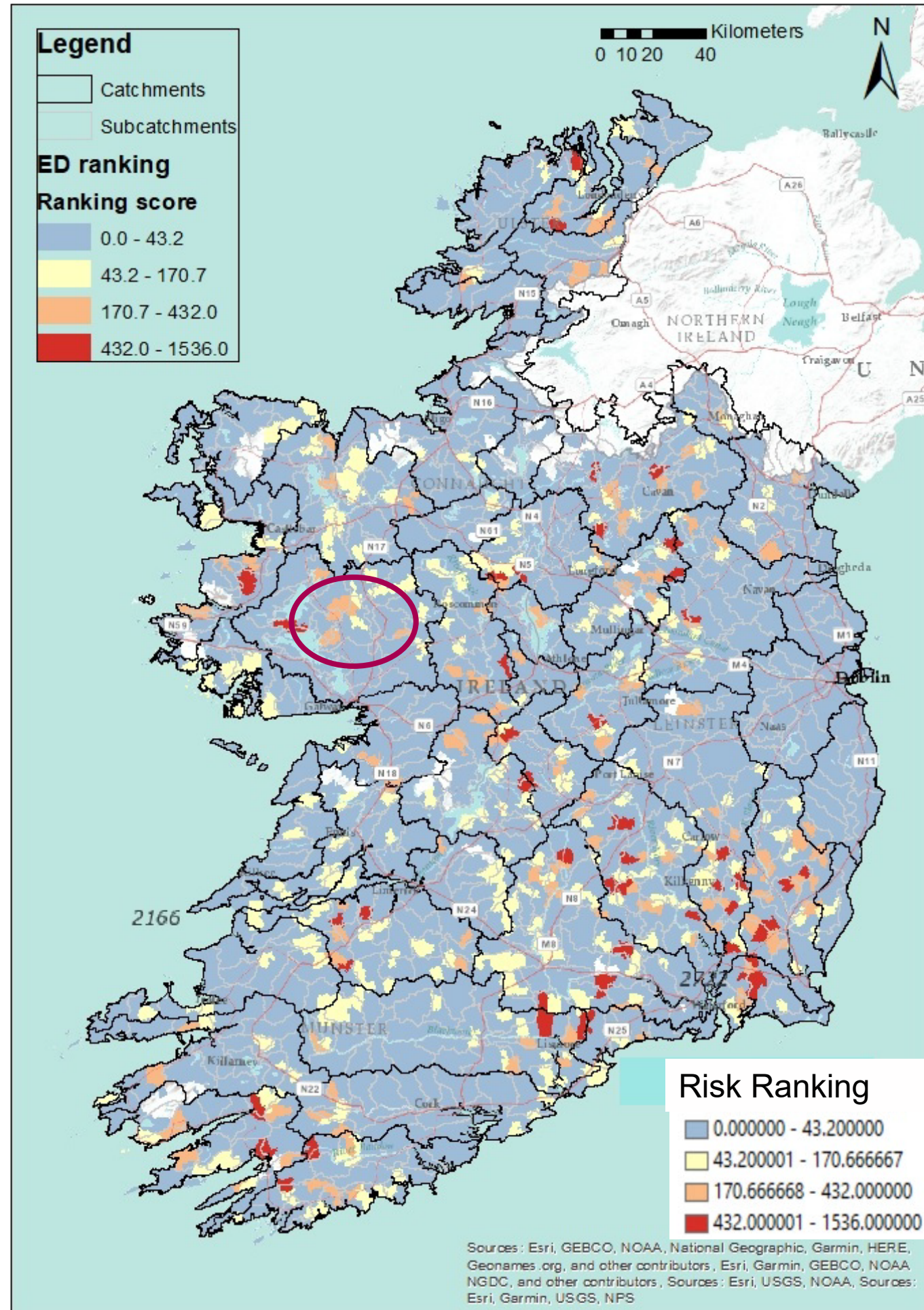
Risk-based predictive modelling tool

# DERIVE technologies



Waterborne VTEC risk mitigation

# DERIVE – story so far



IL  
SI



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Mr Noel Meehan  
(ASSAP Manager)





# Conclusions and Recommendations

- Poor well design is one of the key risk factors for contamination
  - **Recommendation:** Establish stringent guidelines for well design, boring and maintenance.
- Communication with private well owners is crucial to protect public health
  - **Recommendation:** Develop a national information campaign to inform well owners of the risks and promote private well stewardship
- Where areas are high risk, group schemes could be more effectively managed
  - **Recommendation:** Identify key risk areas and liaise with local communities to establish group schemes which are treated and routinely monitored
- Agriculture and Septic Tanks are key sources of *E. coli* and VTEC within Irish groundwater (although relative contribution of each still unknown)
  - **Recommendations:** Liaise with agricultural community and continue efforts to inspect and improve septic tanks
- Climate impacts both *E. coli* and VTEC occurrence in groundwater
  - **Recommendation:** Incorporate private water quality into national climate action plans.



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# Thank *you*

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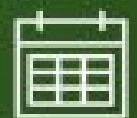


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# Antimicrobial Resistance and the Environment

What has the AREST project taught us?



June 15<sup>th</sup>, 2023



14:00 – 16:30



The Galmont Hotel, Galway



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